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### REMARKS

Claims 24-41 are pending in the application. Claims 24-27 are independent claims.

The previously indicated allowability of Claims 24-26 was withdrawn (paragraph 1 of the Action), "in light of the newly discovered reference to Kubo (6395604).

Claims 24-41 were rejected under Section 103(a) as being unpatentable over newly-cited US Patent 6,395,604 (Kubo) in view of previously-cited US Patent 5,216,275 (Chan). In light of the following comments, this rejection is respectfully traversed and reconsideration is requested.

Independent Claim 27 is directed to a power semiconductor device including a substrate of a first conductivity type, a voltage sustaining region disposed on the substrate, the voltage sustaining region including:

- an epitaxial layer having a first conductivity type;
- at least one terraced trench located in the epitaxial layer and having a plurality of portions that differ in width to define at least one annular ledge therebetween;
- at least one annular doped region having a dopant of a second conductivity type, the annular doped region being located in the epitaxial layer below and adjacent the annular ledge;
- a filler material substantially filling the terraced trench; and
- at least one active region of the second conductivity disposed over the voltage sustaining region to define a junction therebetween.

Regarding Claim 27, the Actions takes the position (1<sup>st</sup> para, page 3) that Kubo discloses a power semiconductor device in fig. 24 comprising: a substrate 20 of a first conductivity type (N); a voltage sustaining region 21 disposed on said substrate 20, said voltage sustaining region 21 including an epitaxial layer 21, col. 7 line 11, having a first conductivity type (N); at least one terraced trench 23, fig. 13(F), located in said epitaxial layer 23; said terraced trench having plurality of portions that differ in width to define at least one annular ledge therebetween; a filler material 40/424/25 substantially filling said terraced trench; and at least one active region 22/27 of said second conductivity P disposed over said voltage sustaining region 21 to define a junction therebetween.

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In response, Applicant respectfully submits that even if Figure 24 of Kubo does disclose:

- a substrate (20)
- a voltage sustaining region (21)
- epi layer (21+22), and
- a trench 23,....

the trench 23 of Kubo is not "terraced". Figure 13(C) through 13(I) of Kubo are intermediate steps in the etching of trench 23, showing what is occurring on a microscopic or atomic level. As described at col. 8, lines 44-47 of Kubo, the solid line in Fig. 11 shows the actual shape of trench 23.

Figures 17 through 21 of Kubo show actual photographs of the trench 23 at various times through the etching process. As is clear from the specification of Kubo, the trench is never *terraced* for the embodiment shown in these figures (see at least Col. 9, lines 39-44 of Kubo).

The actual description of Figures 13(C) through 13(E) of Kubo may be found at Col. 9 lines 56-65. The description is for a "quasi-static" etching reaction. As the heights of the steps shown in Figures 13(C) - 13(E) become on the order of atomic dimensions (which is what happens in the etching process) no terraces are formed, and *the side of the trench is smooth as shown in Figure 11.*

For at least the foregoing reason, Applicant respectfully submits that Kubo alone does not teach or suggest the elements alleged in the Action to be taught thereby.

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The Action then takes the position that while "Kubo does not disclose at least one annular doped region having a dopant of a second conductivity type, the annular doped region being located in the epitaxial layer below and adjacent to annular ledge", Chen "discloses a power semiconductor device in fig. 6 comprises a n-type substrate 4, a n-type epitaxial layer 5 a trench having either n or p-type conductivity region 6, col. 5 line 55, in the epitaxial layer 5. At the time the invention was made; it would have been obvious to one of ordinary skill in the art to *use the doping teaching of Chen* with Kubo's device, because it would have created a device with better on-voltage and breakdown voltage as taught by Chen in col. 1 lines 58-63".

Applicant respectfully submits that *there is no "doping teaching" in Chen* at col. 1, lines 58-63, beyond using adjacent P-type and N-Type regions in the voltage sustaining region. There is no discussion of "an annular doped region having a dopant of a second conductivity type, the annular doped region being located in the epitaxial layer below and adjacent to annular ledge".

In fact, if one of ordinary skill in the art combined the teachings of Kubo with those of Chen, one would merely end up with the structure of Fig. 24 of Kubo, but with alternating P-type and N-type regions in place of region 21.

Kubo uses the v-trench 23 *as a gate*.

Chen is concerned with a voltage sustaining region – Chen in Figure 1 has its gate in a trench the voltage sustaining region (the CB layer) is not described as using a trench.

One of ordinary skill in the art would not *combine trenches that form the voltage sustaining region with the gate trench*.

For all of the foregoing reasons, Applicant respectfully submits that independent Claim 27 is patentable over the teachings of Kubo and Chen.

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With regard to product-by-process Claims 24-26, Applicants acknowledge and appreciate the comments noted in the Action that the process limitations do not carry weight in the device or structure claims. However, Applicant submits herein that he has come forward with evidence establishing an unobvious difference between the claimed product and the prior art product. *In re Murosi*, 710 F.2d 798, 802, 218 USPQ 289, 292 (Fed. Cir. 1983) – and, as described in detail above, (1) the trench 23 of Kubo is not “terraced”, and (2) (as acknowledged in the Action) Kubo does not disclose at least one annular doped region having a dopant of a second conductivity type, the annular doped region being located in the epitaxial layer below and adjacent to annular ledge – and there is no such “doping teaching” in Chen – and in particular, there is no discussion of “an annular doped region having a dopant of a second conductivity type, the annular doped region being located in the epitaxial layer below and adjacent to annular ledge” in Chen.

These are claimed structural elements in Claims 24-26, and provide an unobvious difference between the claimed product recited therein and that achieved by combining the teachings of Kubo and Chen.

Dependent Claims 28-41 are believed to be clearly patentable for at least the same reasons indicated above with respect to Claim 27, from which they depend, and even further distinguish over the cited references by reciting additional limitations.

For example, dependent Claim 32 recites that the epitaxial layer has a given thickness and further comprising the step of etching a first portion of the terraced trench by an amount substantially equal to  $1/(x+1)$  of said given thickness, where  $x$  is equal to or greater than a prescribed number of annular doped regions to be formed in the voltage sustaining region. The Office Action directs Applicant to Fig. 14B, col.4 lines 22-35, but notes that “Kubo does not disclose the etching is substantially equal to  $1/(x+1)$  of said given thickness, where  $x$  is equal to or greater than a prescribed number of annular doped regions to be formed in the voltage sustaining region”. However, the Action then takes the position that “Kubo discloses the trench has specific dimension, col.4 lines 22-35...[a]ccordingly, it would have been obvious to one of

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ordinary skill in art to the trench etching of Kubo in the range as claimed, because it has been held that where the general condition of the claims are disclosed in the prior art, it is not inventive to discover the optimum or workable range by routine experimentation. See *In re Aller*, 220 F.2d 454, 105 USPQ 233, 235 (CCP 1955)."

In response, Applicant submits that the trench 23 in Kubo is for the gate, and has nothing to do with the voltage sustaining region. Accordingly, there would be no motivation to discover "the optimum or workable range" -- it must only be deeper than the body.

In addition, again as described above, the trench 23 of Kubo is not "terraced". As described at col. 8, lines 44-47 of Kubo, the solid line in Fig. 11 shows the actual shape of trench 23. As is clear from the specification of Kubo, the trench is never terraced for the embodiment shown in the figures (Col. 9, lines 39-44).

In addition, with respect to dependent Claims 33-34, the Action notes that "Kubo discloses the power semiconductor device wherein said material 24 filling the trench is a silicon dioxide dielectric material, col. 7, line 17".

Applicant respectfully disagrees, and notes that only the liner of trench 23 is silicon dioxide. The majority of the trench is filled with doped polysilicon, which is a conductor.

With respect to dependent Claim 37, Applicant submits that Kubo provides absolutely no teaching or suggestion of annular ledges with "substantially equal" surface area.

Finally, with respect to dependent Claims 38-39, Applicant submits that what the Action recites as reading upon a "deep body region 27", is in fact not a "deep body region". The body region in Kubo is "22" -- for "27" to be a "deep body region" -- it would need to be deeper than the body region 22 -- which it is not.

Since the Applicants have fully responded to each rejection set out in the Office Action, it is respectfully submitted that in regard to the above amendment and remarks that the pending application is patentable over the art of record and prompt review and issuance is accordingly requested. Should the Examiner be of the view that an interview would expedite consideration of this Response to Action or of the application at large, request is made that the Examiner

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telephone the Applicants' undersigned attorney at (908) 518-7700 in order that any outstanding issues be resolved.

Respectfully submitted,

  
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